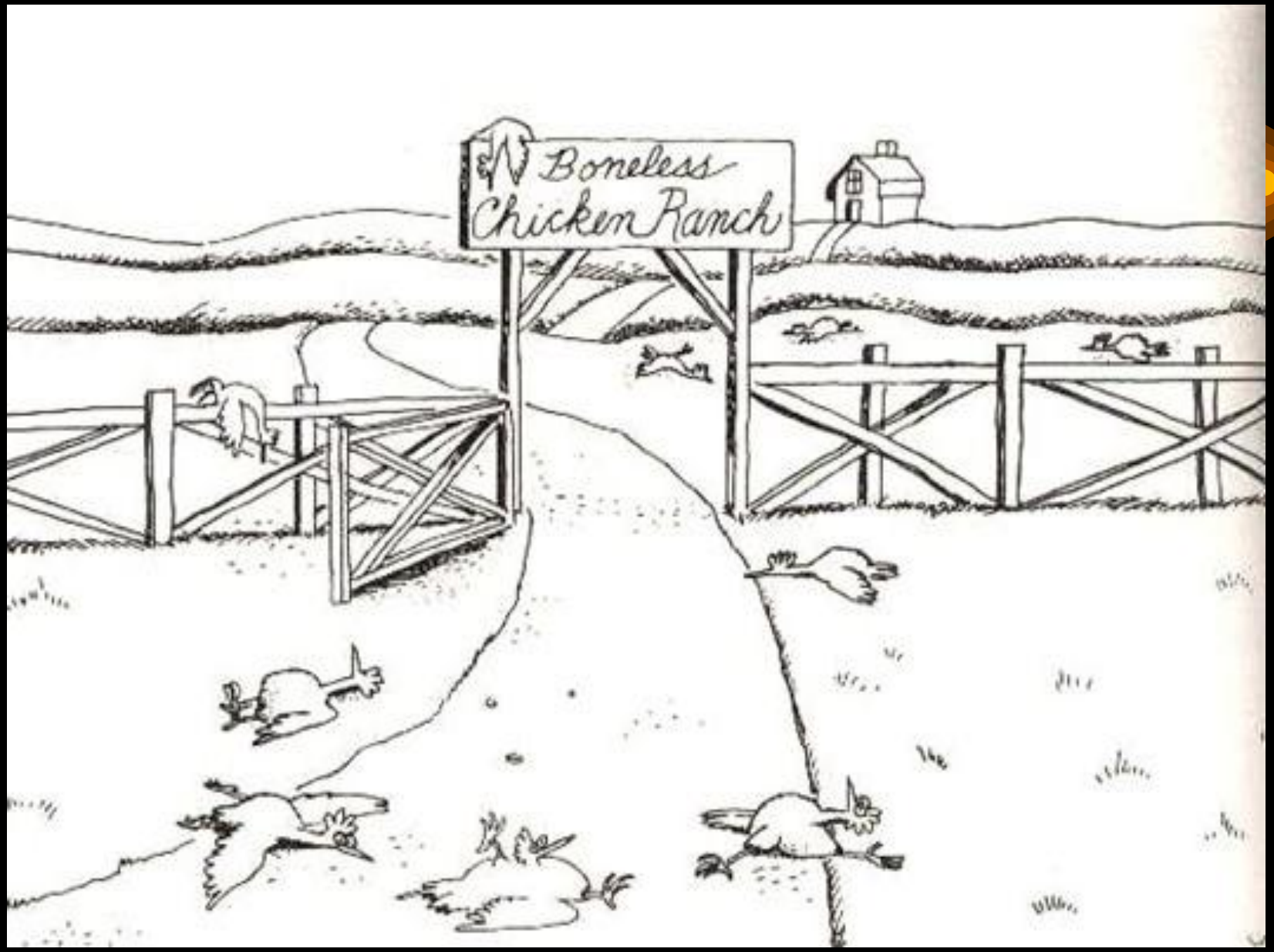
# *Chapter 6-Bones and Skeletal Tissues*

- Histology of cartilage and bone
- Function of the skeletal system
- Bone terminology
- Bone development and growth

Developed by
John Gallagher, MS, DVM

LAS POSITAS COLLEGE

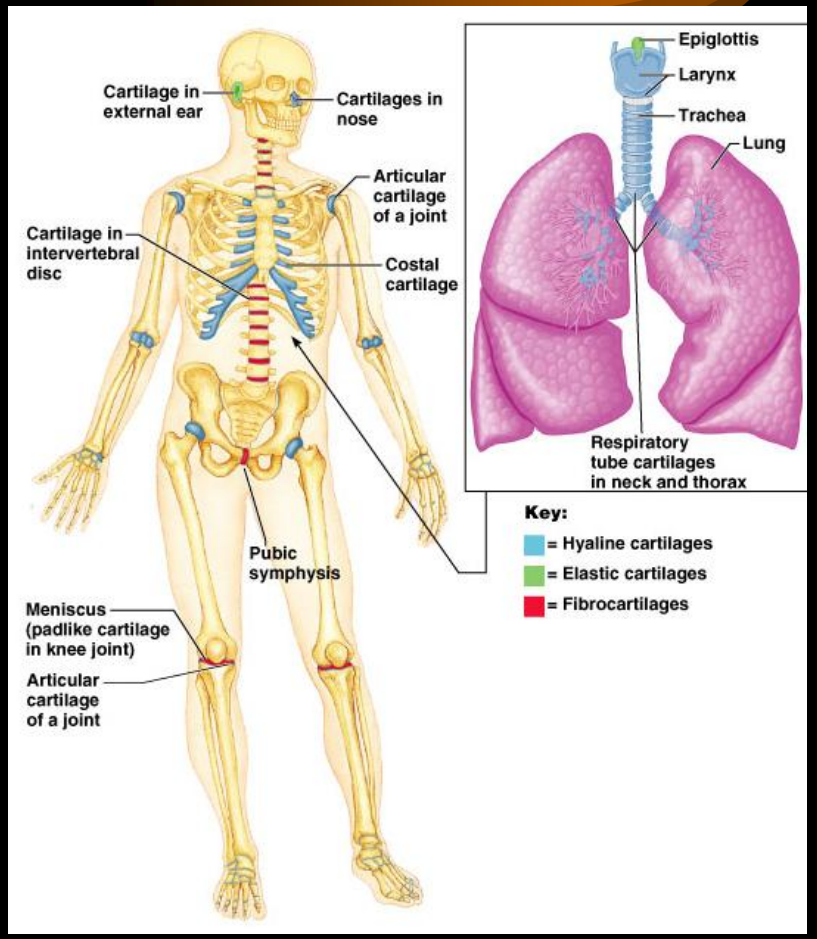

Boneless
Chicken Ranch

# *The skeletal system (like others) is multifunctional* *p 125*

- Support
- Storage of minerals and lipid
- Blood cell proliferation (red marrow)
- Protection (heart, brain, etc.)
- Leverage, Movement
- Metabolic role recently discovered
  - Osteocalcin

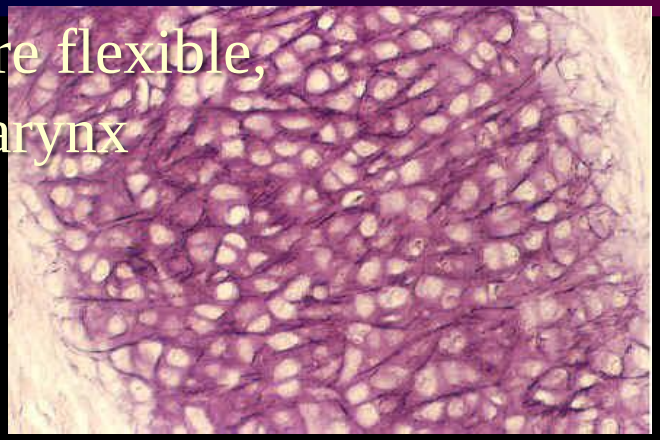
# *Cartilage: Connective tissue*

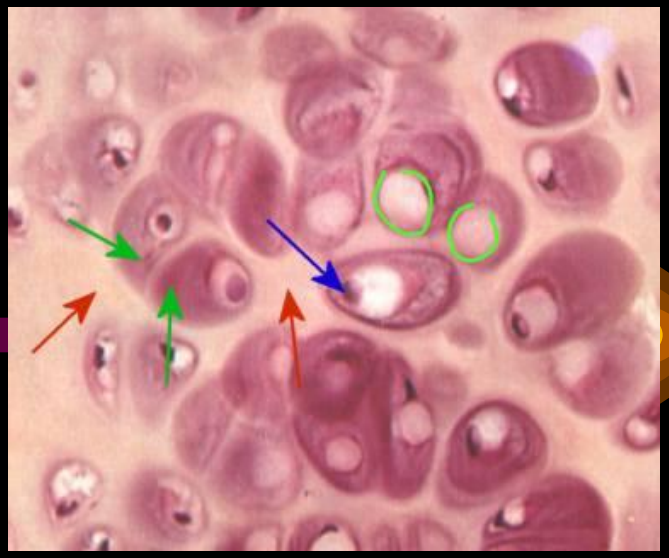
- Chondroblasts lay down the matrix,
  - become chondrocytes when surrounded by EC matrix
- Chondrocytes do not mitose
  - Poor healing
- No nerves, avascular
- On aging, cartilage becomes calcified
  - Less flexible
  - Not bone



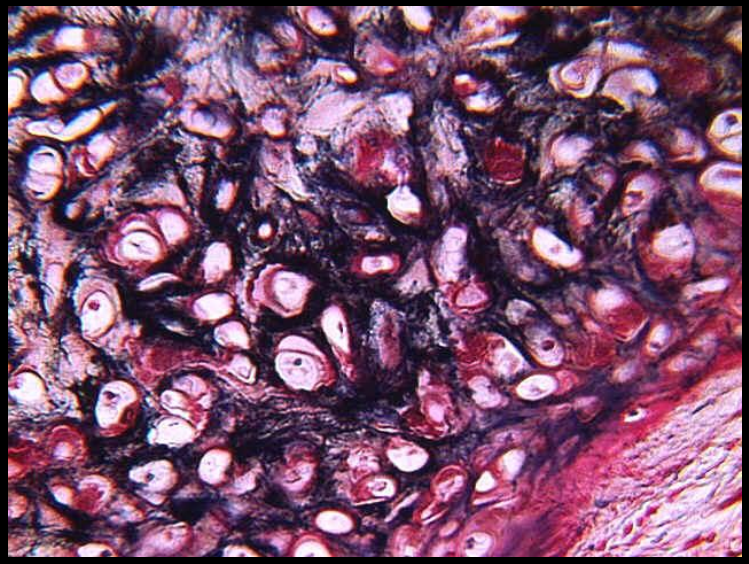
# *Cartilage, cont'd*

Elastic: More flexible,
e.g., ear, larynx





Hyaline
Especially articular

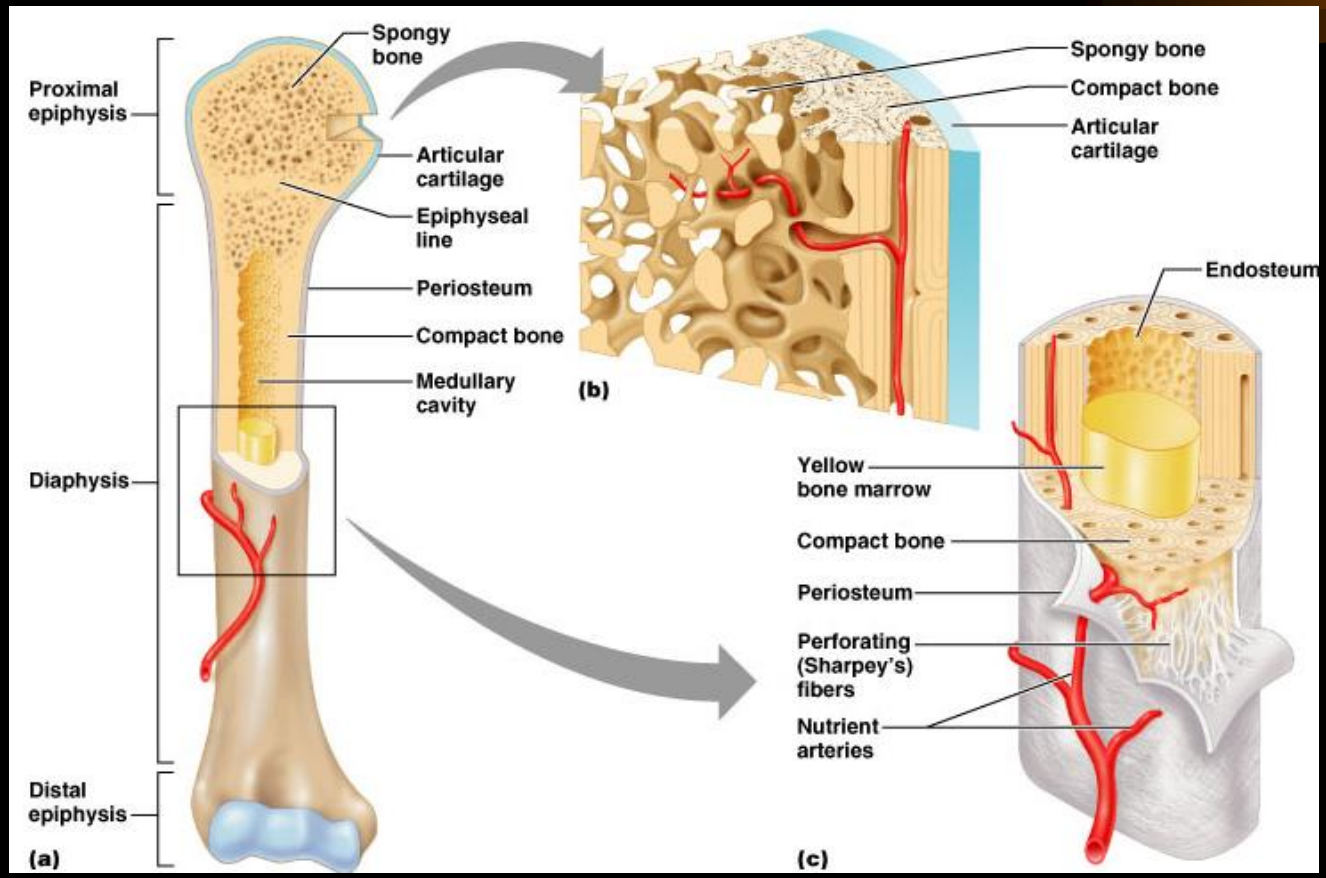


Fibrocartilage
Resists compression—IV Disk, menisci

# Types (shapes) of Bones

- Long
  - Femur
- Short
  - Carpal
- Sesamoid
  - Patella
- Flat
  - Scapula
- Sutural
  - Skull
- Irregular
  - Vertebra

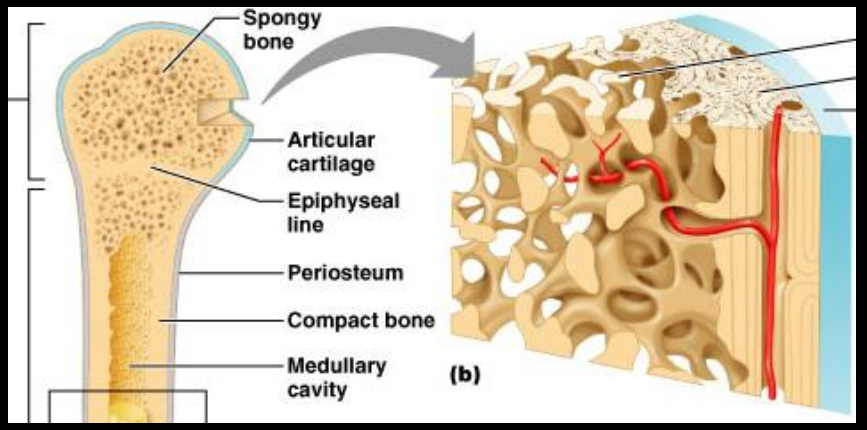
# Typical (Long) Bone Structure




Page 129

# Types of Osseous Tissue

1. Compact Bone
    1. Dense, found in the walls, or cortex
2. Spongy or Cancellous Bone
    1. Network of struts and thin plates (trabeculae)
3. Marrow
    1. Red and Yellow

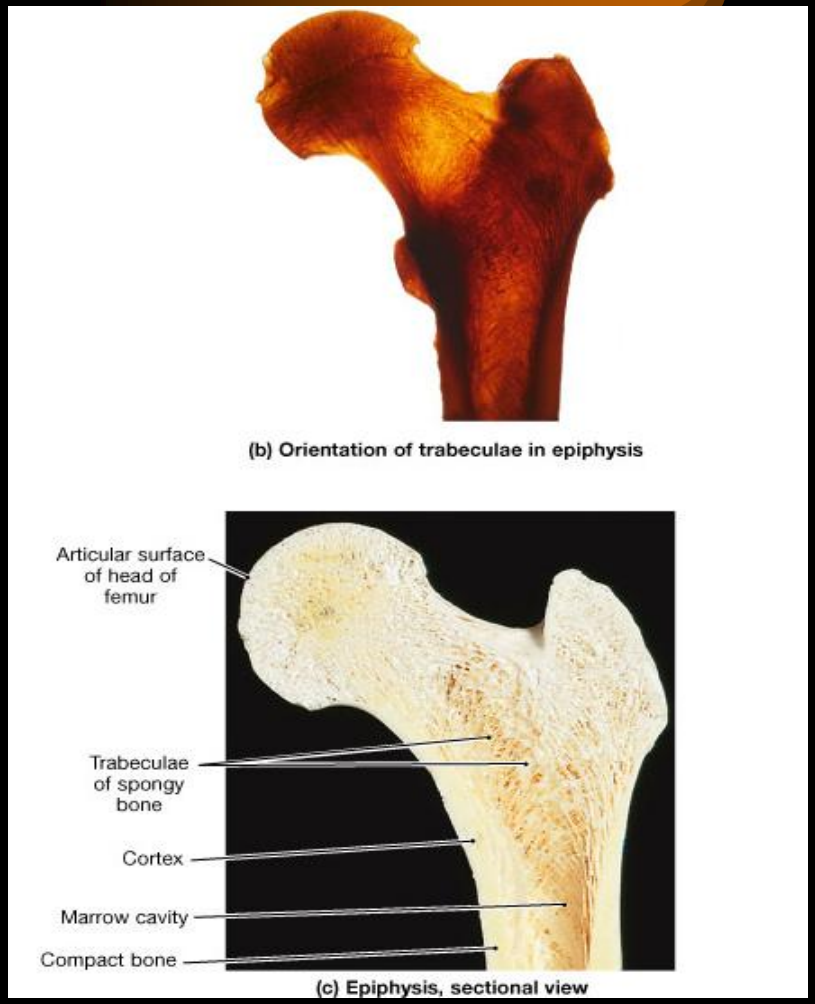


# 1. Compact Bone

- Osteon = functional unit of bone
- The mineral matrix is hydroxyapatite
- Osteoblasts lay down the matrix in layers (lamellae)
  - Become osteocytes when surrounded by EC matrix
  - Lacunae
- Osteoclasts break down bone
  - Often multinucleated

# 2. Spongy Bone

- No osteons
- Lacy network of struts called trabeculae reinforce the bone
- Covered by endosteum



# 3. Marrow

- Red Marrow
  - Active
  - Blood Precursors
- Yellow Marrow
  - Inactive
  - Mostly fat

# Bone markings *Table 6.1, p 131*

- Projection and Process
  - Tuberosity, tubercle
  - Trochanter (only one!)
  - Lines and spines
  - Epicondyles
- Surfaces for Joints
  - Head, facet, condyle
- Depressions and holes
  - Foramen
  - Fossa

- Mostly a lab exercise

# Internal Organization of a Typical Bone

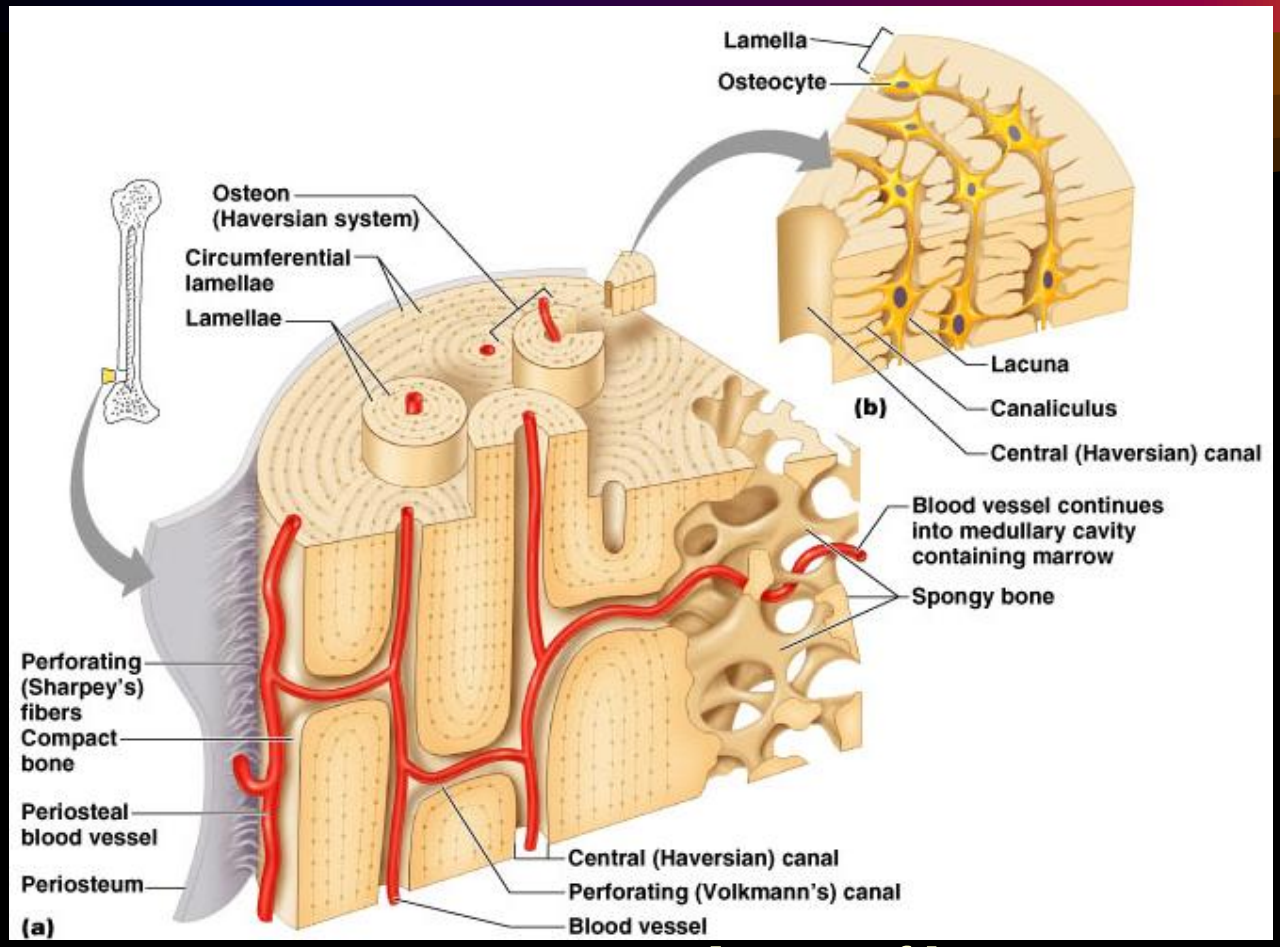
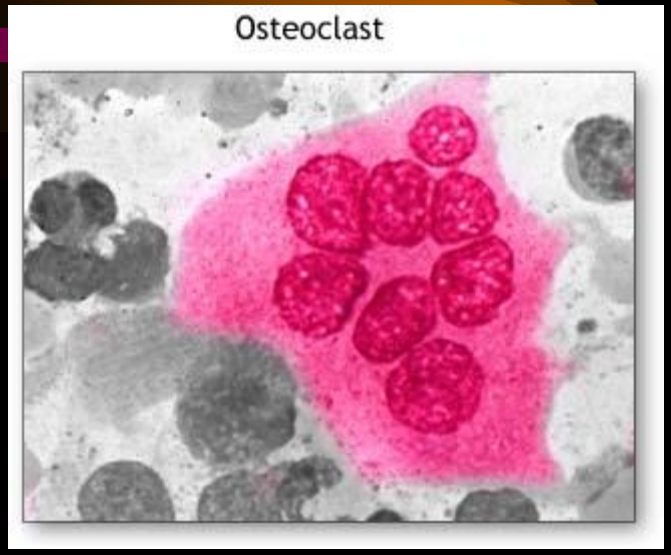



Fig 6.7, p 132

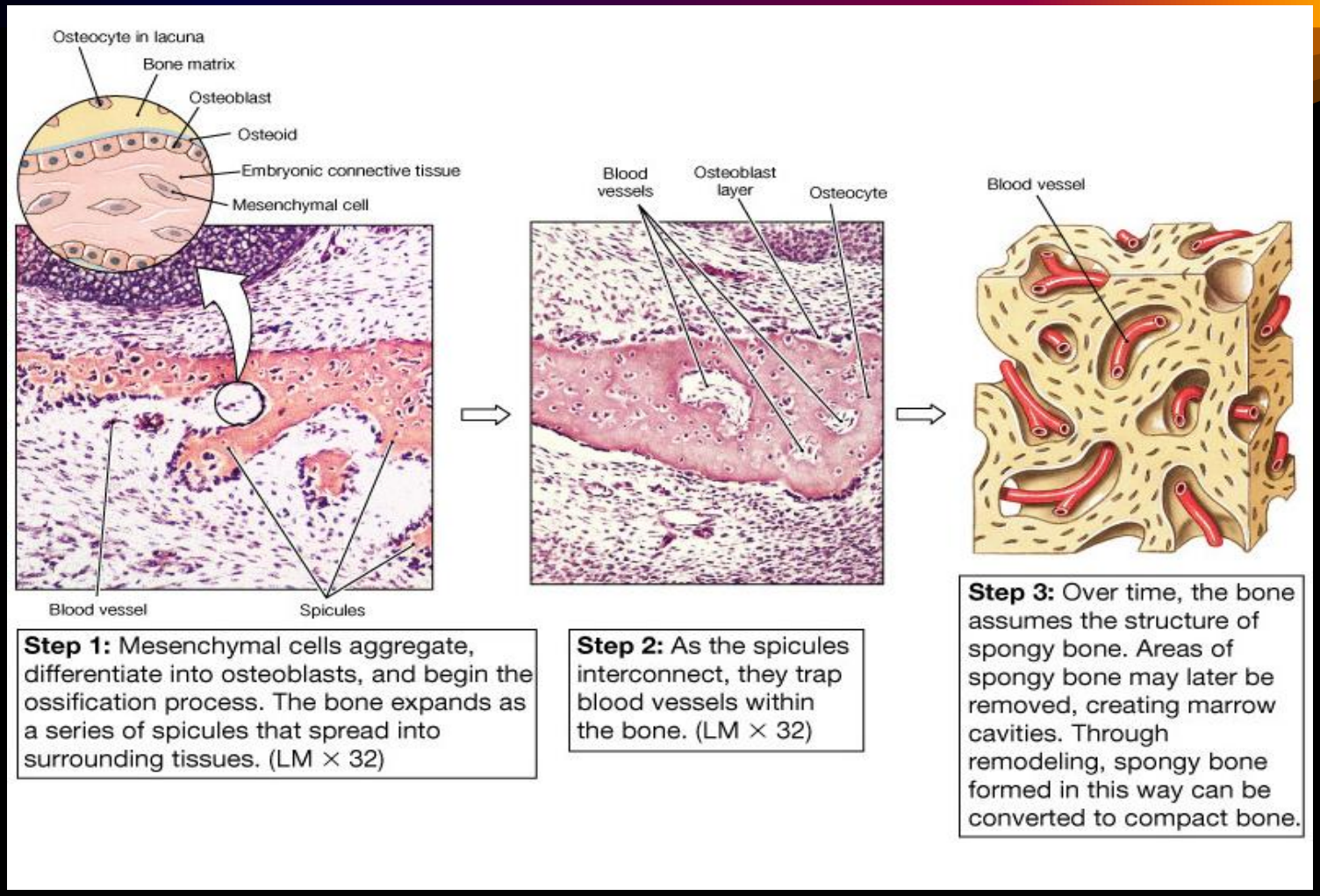
Osteon = Functional unit of bone

# Bone Development

- Osteoblasts produce hydroxyapatite
- Osteoclasts break down the hydroxyapatite
- Intramembranous Ossification
  - Spongy bone
  - Plates of Bone e.g. skull
- Endochondral Ossification
  - Long Bones



# Intramembranous Ossification

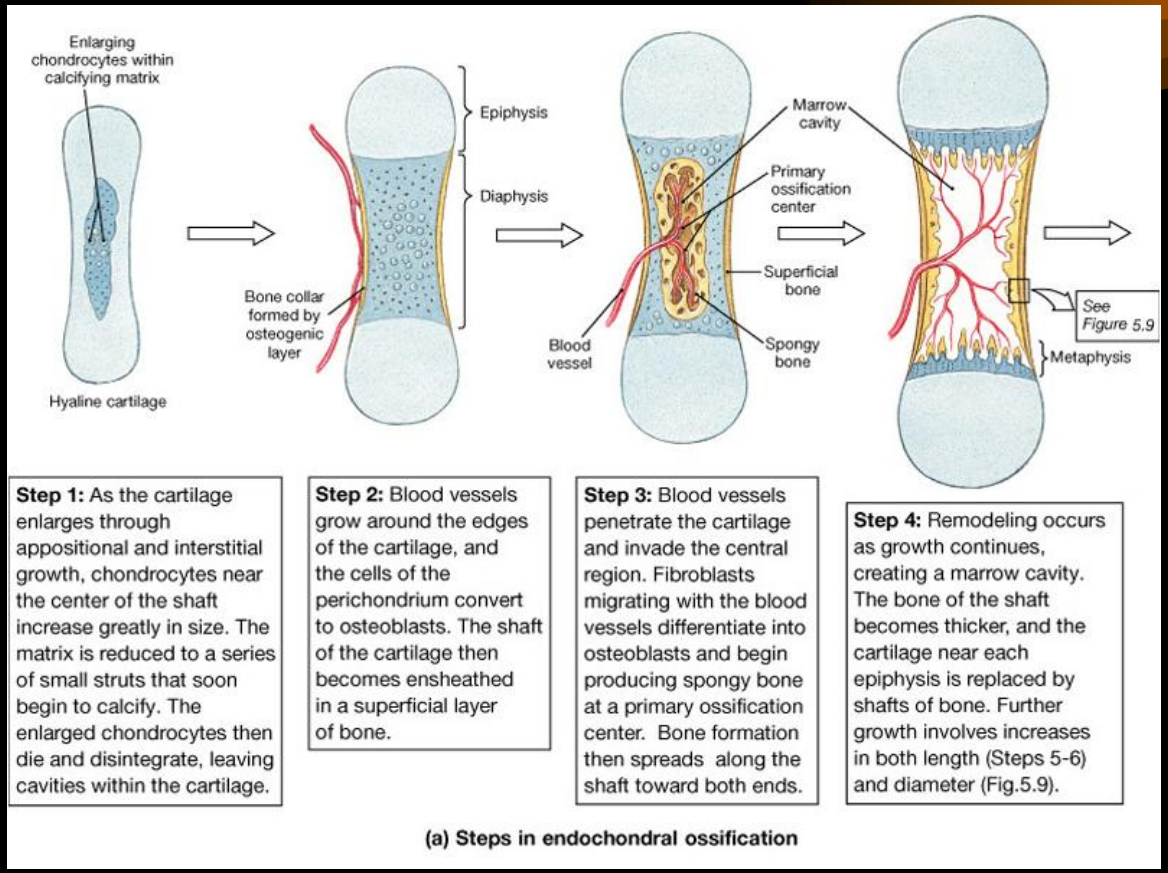



**Step 1:** Mesenchymal cells aggregate, differentiate into osteoblasts, and begin the ossification process. The bone expands as a series of spicules that spread into surrounding tissues. (LM × 32)

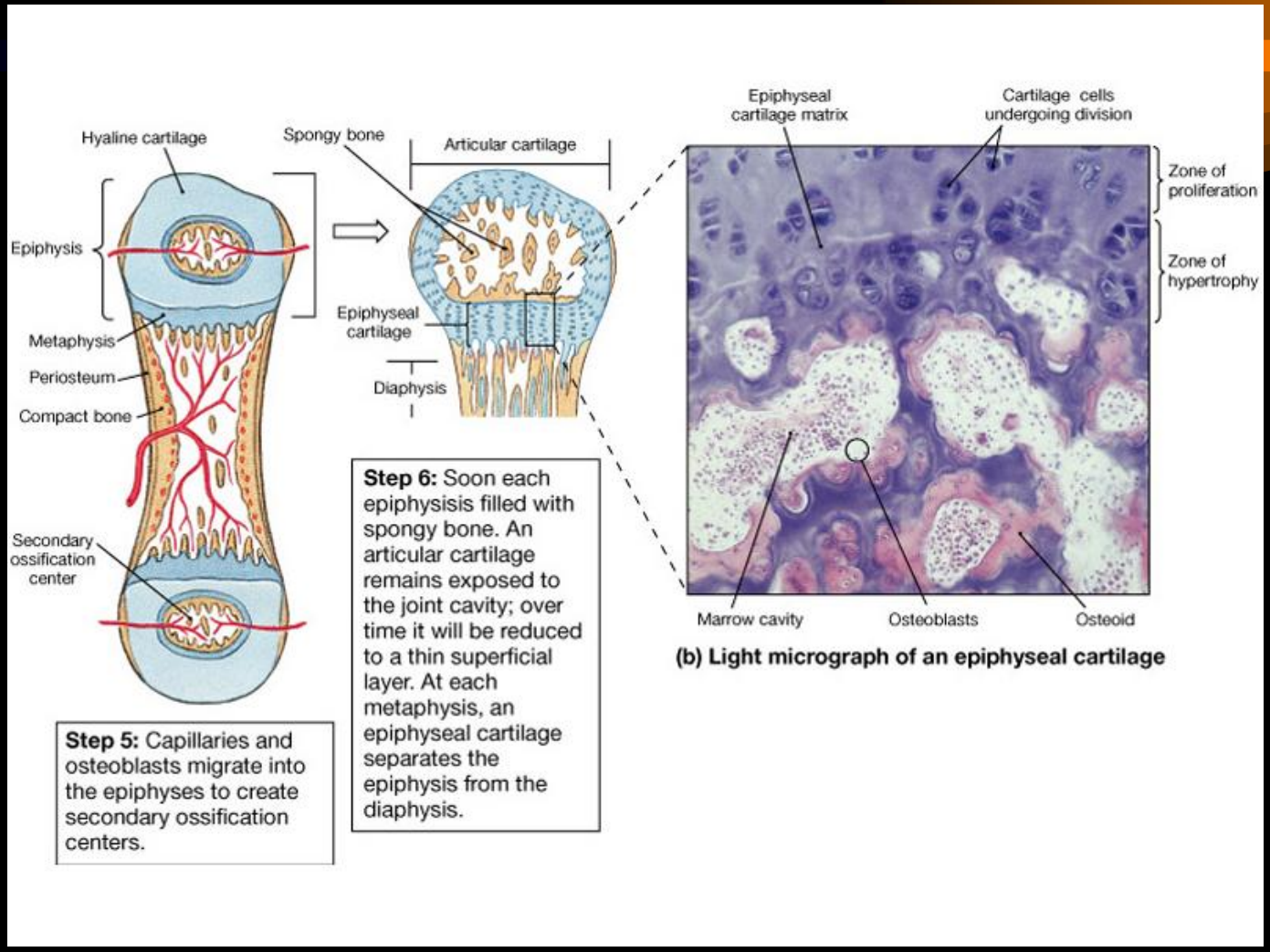
**Step 2:** As the spicules interconnect, they trap blood vessels within the bone. (LM × 32)

**Step 3:** Over time, the bone assumes the structure of spongy bone. Areas of spongy bone may later be removed, creating marrow cavities. Through remodeling, spongy bone formed in this way can be converted to compact bone.

# Endochondral Ossification

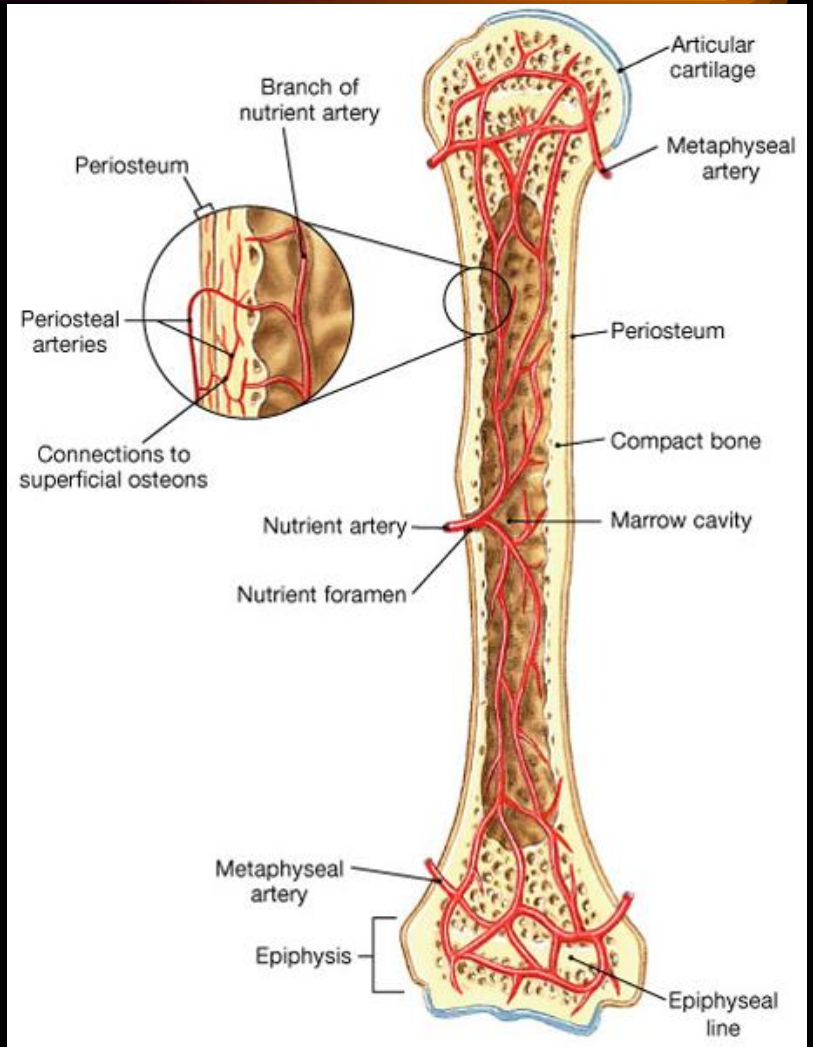

Enlarging chondrocytes within calcifying matrix
Hyaline cartilage
Epiphysis
Diaphysis
Bone collar formed by osteogenic layer
Blood vessel
Marrow cavity
Primary ossification center
Superficial bone
Spongy bone
See Figure 5.9
Metaphysis
Step 1: As the cartilage enlarges through appositional and interstitial growth, chondrocytes near the center of the shaft increase greatly in size. The matrix is reduced to a series of small struts that soon begin to calcify. The enlarged chondrocytes then die and disintegrate, leaving cavities within the cartilage.
Step 2: Blood vessels grow around the edges of the cartilage, and the cells of the perichondrium convert to osteoblasts. The shaft of the cartilage then becomes ensheathed in a superficial layer of bone.
Step 3: Blood vessels penetrate the cartilage and invade the central region. Fibroblasts migrating with the blood vessels differentiate into osteoblasts and begin producing spongy bone at a primary ossification center. Bone formation then spreads along the shaft toward both ends.
Step 4: Remodeling occurs as growth continues, creating a marrow cavity. The bone of the shaft becomes thicker, and the cartilage near each epiphysis is replaced by shafts of bone. Further growth involves increases in both length (Steps 5-6) and diameter (Fig.5.9).
(a) Steps in endochondral ossification

# Endochondral Ossification


Hyaline cartilage
Spongy bone
Articular cartilage
Epiphysis
Epiphyseal cartilage
Metaphysis
Periosteum
Diaphysis
Compact bone
Secondary ossification center
Step 5: Capillaries and osteoblasts migrate into the epiphyses to create secondary ossification centers.
Step 6: Soon each epiphysisis filled with spongy bone. An articular cartilage remains exposed to the joint cavity; over time it will be reduced to a thin superficial layer. At each metaphysis, an epiphyseal cartilage separates the epiphysis from the diaphysis.
Epiphyseal cartilage matrix
Cartilage cells undergoing division
Zone of proliferation
Zone of hypertrophy
Marrow cavity
Osteoblasts
Osteoid
(b) Light micrograph of an epiphyseal cartilage

# Bone Circulation

Nutrient artery
Metaphyseal arteries (2)



# Bone Remodeling

- Bones are metabolically very active
- Osteoid becomes hydroxyapatite
- Site for calcium, phosphorus storage
- Structure and strength are altered by need

# Fractures

- Young vs. old patients
- Simple vs. open (compound) fractures
- Healing:
  - Reduction and stabilization
  - Formation of hematoma
  - Callus—
    - fibrocartilagenous and
    - bony
  - Remodeling—months later

# Osteoporosis (p 141)

- Loss of bone mass ⟶ weakness
- Both compact and spongy bone
- Post-menopausal women, some men
  - Estrogen replacement??
  - Other newer modalities

(a)

(b)

# Osteoporosis (p 141)